Automotive Fuel Tank Inspection Device

1. Field of the Invention

[0001] The present invention relates generally to an inspection devices and particularly to visual inspection devices suitable for inspecting fuel tanks such as those found in automobiles and other vehicles.

2. Background of the Invention

[0002] Millions of automobiles and other wheeled vehicles cross national borders every year. Vehicular fuel tanks are often used by those seeking to smuggle illicit goods across borders. To combat this smuggling, customs and law enforcement officials employ inspection devices, such as for example, videoscopes, to inspect the interior of fuel tanks for contraband.

[0003] Automotive fuel tanks typically consist of a tank having an interconnected filler tube or neck. The filler neck typically includes a flapper valve and a rollover valve, both of which are usually biased to snap shut. Visual inspection of the interior of the fuel tank using a remote inspection device, such as a borescope, typically requires inserting an optical probe into the filler neck, passing the probe through the flapper valve and into the fuel tank body. The optical probe typically includes an insertion tube having imaging optics disposed at a distal end thereof. Passing the probe through the flapper valve necessitates pushing the flapper valve open. Typically, the optics that are disposed at the end of the probe are relatively fragile, and unsuited for pushing the flapper valve open. Furthermore, the probes may become snagged on the flapper valve, hindering both its insertion and removal. Thus, conventional optical probes encounter difficulties when used to inspect automotive fuel tanks for contraband.

[0004] One approach to overcome the above stated problem involves inserting a funnel or tube into the filler neck and using the end of the funnel or tube to open the flapper valve and rollover valve. The optical probe is then fed into the funnel and hence into the interior of the fuel tank. There are a number of drawbacks to this approach. A first drawback is that the inspector operating the video probe must also carry around a funnel

or tube in addition to the probe video apparatus. Secondly, the funnel or tube is separate from the probe and can be removed independent of the probe, thereby allowing the flapper valve or the rollover valve to come into contact with the optical probe. As previously noted, the distal or optical end of the video probe is a relatively delicate optical instrument that is ill suited for making contact with either the flapper valve or the rollover valve. In particular, the pinching of the probe by the closing action of either the flapper valve of the rollover valve may damage the optical probe.

Summary of the Invention

[0005] In one embodiment, the present invention includes a vehicular fuel tank inspection device. The fuel tank inspection device includes a handset having a display. The fuel tank inspection device further includes a guide tube coupled to the handset as well as an elongated flexible probe that carries imaging optics at a distal end thereof coupled to the handset. The elongated flexible probe is at least partially disposed within the guide tube and is movable between a first position and a second position with respect to the guide tube, whereby the distal end is movable into and out of the guide tube, so as to prevent the flapper valve or the roll over valve from pinching the flexible probe and damaging the flexible probe.

[0006] According to another embodiment, the present invention includes a device for inspecting a tank having a filler tube that includes a flapper valve. The device includes a handset having a display and a probe that is coupled to the handset. The probe is defined by a first end having imaging optics, the imaging optics providing a field of view of a target or object wherein images of objects within the field of view are shown on the display. The device further includes a guide tube coupled to the handset. The guide tube defines a longitudinal passageway and is disposed about the probe such that the guide tube is slideable with respect to the probe, and in which the first end may be selectively extended from and retracted into the guide tube.

[0007] According to yet another embodiment, the present invention includes an inspection device for inspecting the interior of an enclosed volume. The inspection device includes a display and a probe coupled to the display. The probe includes a first end having imaging optics. The inspection device further includes a protective sleeve

removably engageable with the probe, whereby the first end is movable with respect to a distal end of the protective sleeve.

[0008] According to yet another embodiment, the present invention relates to a method of inspecting a vehicular fuel tank. The method further includes the steps of inserting a guide tube of a remote video inspection device into a fuel tank, moving an elongated flexible probe of said remote video inspection device to a first position, whereby the distal end of said probe is positioned external to the guide tube. The method further includes the step of inspecting the interior of the fuel tank, and subsequently retracting the elongated flexible probe, the distal end being positioned inside the guide tube, and withdrawing the guide tube from the fuel tank.

Brief Description of the Drawings

[0009] **Figure 1** is a perspective view of an inspection device according the present invention;

[0010] **Figure 2** is a longitudinal cross sectional view of an guide tube useable in an inspection device according to the present invention;

[0011] **Figure 3** is a fragmentary side elevation view of a handset and insert/guide tube coupling of an inspection device according to the present invention;

[0012] **Figure 4** is a fragmentary side elevation view of an alternative embodiment of the present invention,

[0013] **Figure 5** is a series of cross sectional side elevation view of possible insertion end guide shapes for the guide tube of the present invention; and

[0014] **Figure 6** is perspective view of an alternative embodiment of the present invention.

Detailed Description of the Preferred Embodiments

[0015] Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Whenever possible, the same reference numerals will be used throughout the drawings to refer to the same or like parts for clarity.

[0016] Referring to **figure 1** there is shown a video probe fuel tank inspection device **10** having a handset **12,** including a display **14** and an extending flexible insertion tube **16.** One example of the described handset **12** is a VideoProbe® XL Pro™ borescope available from Everest-VIT, Inc. of Flanders, NJ. One end of the insertion tube **16** is equipped with a bendable neck region and imaging optics **18** that allow items within their field of view to be displayed on the display **14.** The fuel tank inspection device **10** further includes a guide tube **20** coupled to the handset **12.** The guide tube **20** is a flexible member having a stiffness similar to that of the insertion tube **16.** The guide tube **20** is configured to resist crushing forces, such as for example by including a helical steel coil covered by a polymer coating, thereby protecting the insertion tube **16** and its associated imaging optics **18.** The guide tube **20** may have a substantially annular cross section, although other cross sectional shapes may be preferred for specific operating environments. The interior of the guide tube **20** is sized to allow the insertion tube **16** to slide within the guide tube **20** without binding. In one embodiment, the guide tube **20** has an interior diameter of about 6 mm and an exterior diameter of about 10 mm. Preferably, the outer surface of the guide tube is a slick, non-binding surface such as, for example a surface coated with polyurethane, Teflon® or similar material. In one embodiment, the guide tube **20** is of similar construction to the insertion tube **16** of the videoscope. For example, as shown in **figure 2**, the guide tube **20** may include an helically wound spiral tube **20a**, a flexible metallic braid layer **20b** and a outer polyurethane layer **20c**. An example of the construction of an insertion tube that is suitable for use as a guide tube **20** is found in U.S. Patent No. 6,083,152 to Strong, which is herein incorporated by reference in its entirety. In an alternative embodiment, the guide tube **20** may be a polymeric tube.

[0017] As an additional safety feature, the automotive inspection device **10** of the present invention may be configured as a grounded element in order to prevent a static electrical discharge in the vicinity of fuel vapors. In one embodiment that incorporates this safety feature, the automotive fuel tank inspection device **10** is provided with a grounding wire for connection to a ground terminal (not shown).

[0018] In an other embodiment, such as that shown in **figure 6**, the guide tube **20** may include an external stop **100**. In this embodiment, the guide tube is removably

engageable with the fuel tank, such as, for example, the external stop may have a complimentary form factor so as to engage a predetermined region of the filler neck. The external stop **100** is configured to prevent the over insertion of the guide tube **20** and the insertion tube **16** into the interior volume to be inspected. The external stop **100**, may be, for example a bulbous member that contacts the outside of the car or an exterior portion of the filler neck. The external stop **100** may be integrally formed with the guide tube **20** or may be a separate adjustable piece that is coupled to the guide tube **20**. In one embodiment, the external stop is positioned such that the handset **12** cannot be positioned any closer than 18 inches from vehicle in normal use.

[0019] The guide tube **20** is slideably engageable with the insertion tube **16**. The guide tube **20** is shorter than the insertion tube **16**. The end of the guide tube **20** adjacent to the imaging end **17** of the insertion tube **16** is configured to facilitate insertion of the guide tube **20** into an automotive fuel tank. The profile of the insertion end of the guide tube **20** may, for example, be square, bullet shaped or tapered. Examples of suitable shapes for the insertion end of the guide tube **20** are shown in **figure 5**. The guide tube **20** may be of either an articulated or non-articulated design.

[0020] The guide tube **20** is moveable between at least a first position and a second position with respect to the insertion tube **16**. **Figure 3** shows an embodiment of the present invention in which the guide tube **20** is coupled to the handset **12** by a flexible strap **26**. The guide tube **20** includes a collar **28** configured to engage the connection between the insertion tube **16** and the handset **12**. In the embodiment shown, the collar **28** includes a chamfered opening **30** for engaging the junction of the insertion tube **16** and the handset **12**. The flexible strap **26** is preferably coupled to both the hand set **12** and the guide tube **20** by removable fasteners **32**, such as, for example threaded fasteners. Using removable fasteners **32** allows the guide tube **20** to be readily replaced by the user if the guide tube **20** becomes damaged or too worn to perform properly.

[0021] The length of the flexible strap **26** is chosen such that when the guide tube **20** is a first position with respect to the insertion tube **16** the imaging end **17** of the insertion tube **16** is protected by the guide tube **20**. In one embodiment, the flexible strap **26** is of sufficient length such that when it is fully extended the imaging end **17** of the insertion tube 16 is flush with the end of the guide tube **20**. In an other embodiment, the flexible

strap **26** is of sufficient length such that when it is fully extended the imaging end **17** of the insertion tube **16** is retracted within the end of the guide tube **20**. In an other embodiment, the flexible strap **26** is of sufficient length such that when it is fully extended the imaging end **17** of the insertion tube **16** protrudes from the end of the guide tube **20**.

[0022] The relative motion of the guide tube **20** in the opposite direction is constrained by the collar **28**. When the handset **12** is moved so as to extend the imaging end **17** of the insertion tube **16** from the guide tube, the motion is limited by the collar **28** contacting contact a surface **34** of the handset **12**. The flexible strap **26** is sized so that imaging end **17** of the insertion tube **16** may be extended from the guide tube a sufficient amount, such as, for example about three inches from the end of the guide tube **20** so as to allow the interior volume of the fuel tank to be visually inspected without moving the guide tube **20**.

[0023] **Figure 4** illustrates an alternative embodiment of limiting the movement of the guide tube **20** with respect to the insertion tube **16**. A stop collar **38** is coupled to the insertion tube **16** in at a predetermined distance from the handset **12**. The stop collar **38** is disposed within the guide tube **20**. The end **36** of the guide tube **20** closest to the handset is configured such that the end cannot move pass the stop collar **38**. Thus, relative motion of the guide tube **20** with respect to the insertion tube **16** is limited to the distance between the stop collar **38** and the handset **12**. When the end **36** of the guide tube **20** is adjacent to the stop collar **38** the imaging end **17** is protected by the insertion end **34** of the guide tube **20**. When the end **36** of the guide tube **20** is adjacent to the handset **12** the bending neck portion of the insertion tube **16** is outside of the guide tube **20** and is free to be manipulated to inspect the interior volume of the fuel tank.

[0024] The embodiment of the present invention shown in **figure 4** lends itself to an embodiment in which the insertion tube **16** is free to articulate and rotate independent of the guide tube **20**. As will be appreciated by those skilled in the art, a wide variety of design choices for movement restricting stops are apparent after considerations of the examples contained herein and without departing from the teachings detailed above.

[0025] In operation, and before inserting the guide tube **20** into an automotive fuel tank, the imaging optics **18** at the end of the insertion tube **16** are positioned adjacent to the end

of the guide tube **20** in such a manner that the imaging optics **18** and bending portion of the insertion tube **16** are protected. Typically this is accomplished by moving the handset **12** away from the automobile, thereby retracting the imaging end of the insertion tube **16** substantially within the insertion end **34** of the guide tube **20**. A stop, such as, for example a flexible strap **26** or a stop collar **38** limits the amount that the imaging end **17** may be retracted into the guide tube **20**. The position of the imaging end **17** with respect to the insertion end **34** of the guide tube **20** is preferably selected such that the imaging optics **18** are protected from damage without unduly limiting the ability of the imaging optics to provide images to the handset **12**. For example, in some instances it may be preferable to have the imaging end either substantially flush with the insertion end of the guide tube **20** or only slightly withdrawn into the insertion end of **34** of guide tube **20**. In this protected state, the guide tube **20** and insertion tube **16** are each inserted into the filler neck of the fuel tank. The guide tube **20** pushes open the flapper valve and thereby prevents the insertion tube **16** from contacting the flapper valve. The insertion end of the guide tube **20** is placed within the interior volume of the fuel tank. Without moving the guide tube **20**, the imaging end and the bending portion of the insertion tube **16** are extended from the guide tube **20**. The imaging end and the bending portion of the insertion tube **16** are extended from the guide tube **20** by moving the handset **12** towards the guide tube **20**. Typically, the imaging end and the bending portion of the insertion tube **16** are extended about 3 inches from the insertion end of the guide tube **20**.

[0026] Withdrawal of the insertion tube **16** and the guide tube **20** is accomplished by reversing the afore described procedure. First and without first moving the guide tube **20**, the handset **12** is moved away from away from the guide tube **20**, thereby retracting the imaging end of the insertion tube **16** substantially within the insertion end **34** of the guide tube **20**. Once the imaging optics and bending neck are protected by the guide tube **20,** the guide tube **20** and the insertion tube **16** are removed from the automotive fuel tank and its filler neck. During the removal, care is taken so that the imaging optics and bending neck region are not extended from the guide tube **20**. Alternatively, the user may simply pull on the handset **12** which will result in the retraction on bending neck and imaging optics into the guide tube **20**, and the removal of the entire assembly from the fuel tank and its filler neck.

[0027] It will be readily apparent to those of ordinary skill in the art of that the present invention may be adapted to other forms, such as, for example, commercially available videoscopes or to optical inspection devices that utilize optical fibers to transmit an image from the end of the insertion tube **16** to the handset or viewer.

[0028] It will be apparent to those skilled in the art that various modifications and variations can be made to the present invention without departing from the spirit and scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.